April 7, 2005

Subject: Comments on the article — Human Auditory Steady State Responses to Binaural and Monaural Beats by D.W.F. Schwarz and P. Taylor, published in Clinical Neurophysiology 116 (2005) 658–668.

This is a very well written, great article.

Back in the 1990s the Institute published several papers addressing the neurological effects of binaural beating. Rather than incessantly repeating this effort and risk appearing to generate self-serving research papers, we hoped that others would read our research and thereby be encouraged to publish their own works in the field. Third-party testimonials would prove much more valuable than in-house work.

Although this paper, Human Auditory Steady State Responses to Binaural and Monaural Beats, does not address the consciousness altering effects of binaural beats within the context of the Hemi-Sync process, it does well document an auditory steady state evoked response (ASSR) at a specific binaural beat frequency.

There is nothing in this paper that contradicts anything we have said or published about the neurological effects of binaural beating. In fact, much has been reinforce – even though languaged differently. For example, "auditory steady state response" is used rather than "frequency-following response" and the expression "acoustic beating tones" is used interchangeably with the more common idiom "monaural beats".

I have never read a more eloquent (and complex) explanation of binaural beating:

> "A beating tone may also be heard when each sinusoidal component is presented, in isolation, to a different ear (Tobias, 1963). This binaural beat, a much fainter sensation, is restricted to relatively low component frequencies of a few hundred Hz (Licklider et al., 1950) that are temporally encoded as spike firing phase-locked to the sound wave (Rose et al., 1968). In the mammalian auditory system robust phase locking, to tone frequencies up to a few kHz, has been demonstrated in cochlear nerve fibers (Palmer and Russell, 1986) and in the spherical bushy cells of the antero-ventral cochlear nucleus (Goldberg and Brownell, 1973) whose axons project to the medial superior olivary (MSO) nucleus (Goldberg and Brown, 1969; Smith et al., 1993). MSO neurons receive the inputs from both ears separately, each at one of their two dendritic trees (Ramon Y Cajal, 1909; Schwartz, 1977), where the sound waves are, presumably, replicated (Agmon-Snir et al., 1998). The membrane potential at the MSO neuron spike trigger zone, close to the soma, is thought to reflect a combination of the sound waves from both ears, and the output spike rate of MSO neurons is modulated at the envelope time pattern of the sum of both input waveforms (Yin and Chan, 1990). Thus, firing patterns of inferior colliculus neurons, the target of MSO axon projections, can reflect a binaural beat (Kuwada et al., 1979). In the tonotopic array of the MSO, each neuron is tuned to a narrow frequency band, similar to cochlear nerve fibers, and different tones in both ears may be combined only if they fall in the same critical frequency band. Thus, different tones in each ear can be heard as binaural beat only if they are separated in frequency by less than a critical band (like acoustic beats) and have frequencies sufficiently low to be temporally encoded (unlike acoustic beats)."

There are three specific areas of the paper of particular interest to me:

1. Gamma – This is the second study (Hink et al., 1980, being the first) reporting a brainwave response to gamma frequency binaural beating. This is important because all Focus Levels above F-21 use gamma stimulation within the Hemi-Sync mix.

2. Focus of attention – For the first time consideration is given to the idea that attending to or listening for the binaural beat may be a factor in developing an auditory steady state response (a brainwave frequency-following response).

> "During dichotic sound stimulation two mutually exclusive perceptions may also occur. For example, a dichotic presentation of the second of two noises, delayed between the ears, can cause either a noise sensation at a specific location in space or a musical pitch (Fourcin, 1970). A binaural beat ASSR could, therefore, depend upon a focus of attention on the beat sensation."

> "A few subjects with musical training attempted to assign a musical interval value to the difference between both component tones. As this effort appeared to suppress the generation of a binaural beat ASSR, we instructed subjects to attend to one warbling tone and not to try and identify separate components."

   I had always assumed that one did not consciously need to "hear" or attend to the binaural beating within the Hemi-Sync process. Apparently there is some evidence to the contrary.

3. Multiple cortical locations of auditory steady state responses – What area of the cortex is affected by the binaural beating?

> "The phase shift across the electrode array is evidence for more than one origin of the 40 Hz oscillations."

> "It is reasonable to assume that a major source of the monaural-and binaural beat ASSRs is located in the auditory cortex, on Heschl's gyri within the Sylvian fissure. If there was only this one source of the oscillation we would expect the amplitudes to vary across the antero-posterior scalp dimension, as in Figs. 3–6, however, phases should remain relatively constant. We compared the phases of the 40 Hz regression sinusoids derived from records during the stimulus epochs at the various electrode locations. Several such regression curves are shown superimposed in Fig. 7, (top). A systematic fronto-occipital phase shift is evident in both the monaural (top left) and binaural beat ASSRs (top right). Frontal oscillation phases lead occipital phases by w3–7 ms and regression sinusoids at intermediate locations exhibited an orderly, sequential phase progression in an anterior to posterior direction. We recorded such an orderly phase progression from locations at which stimulus response amplitudes were significantly greater than oscillation amplitudes during intervals or controls, provided the regression curve amplitudes were larger than w50 nV. The orderly phase progression

tended to be obscured in cases of low beat ASSR signal to background noise ratios, presumably due to phase interaction of the relevant and irrelevant regression curves. In Fig. 7, (bottom) we plotted the mean phases and 95% confidence intervals at a greater number of electrode positions for one exemplary beat ASSR. The 95% confidence intervals tended to overlap for electrodes at similar levels along the anterior–posterior axis, but not at widely different levels, illustrating significant phase differences between anterior and more posterior recording sites. The phase shifts suggest that oscillating neuron networks at different locations contribute to the acoustic and binaural beat ASSRs."

This is highly significant – to think of Hemi-Sync as being able to effect multiple areas of the cortex. This is the first time I have seen this addressed in writing.

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